PRRIP CHOKEPOINT PROJECT MEMORANDUM

DATE:	February 7, 2024	**ACE PROJECT NO.:** NEHW05.03
TO:	Seth Turner, PPRIP Executive Director's Office	DRAFT FOR PRRIP CHOKEPOINT PLANNING WORKGROUP REVIEW
FROM:	Michelle Martin, PE, Anderson Consulting Engineers, Inc. Brian Murphy, PhD, PE, River Works Ltd	
SUBJECT:	North Platte Chokepoint Phase II Alternative Screening	

The Platte River Recovery Implementation Program (PRRIP or Program) continues efforts to achieve and maintain hydraulic capacity of 3,000 cfs on the North Platte River below minor flood stage, which is defined by the national Weather Service (NWS) as 6.0 ft at the North Platte River at North Platte (06693000) gage adjacent to the Highway 83 bridge. This gage represents a reach known as the North Platte Chokepoint that extends for several miles upstream and downstream of the Highway 83 bridge. Starting in the late 1980s, hydraulic capacity of the North Platte River through this reach was significantly reduced and is now on the order of 1,750 cfs. As a result, the North Platte Chokepoint limits the Program's ability to deliver water from the Lake McConaughy Environmental Account (EA) upstream to the Associated Habitat Reach (AHR) downstream for the benefit of threatened and endangered species.

The Program selected Anderson Consulting Engineers Inc. (ACE) to conduct the current North Platte River Chokepoint Engineering Service Project in May of 2023. The EDO has defined the project goal as identifying and screening alternative solutions to increase hydraulic capacity through the Chokepoint and/or provide delivery of flows downstream of the Chokepoint through other systems.

The purpose of this memo is to provide a summary of information reviewed, revised and/or developed for a short list of alternatives identified during the initial phase of the project and documented in a memo dated August 21st, 2023. The short-listed alternatives considered and discussed in this memo focus on standalone alternatives including: 1) no-action, 2) South Platte reservoir storage, 3) reduction of upstream sediment sources, 4) purchase of existing irrigation infrastructure for bypass, 5) construction of a bypass canal, and 6) channel modification/sediment removal. Additional concepts that could enhance standalone alternatives also discussed include modification of the Tri-County Canal Diversion (TCCD).

Initial Screening of Alternatives

An initial investigation and screening of the short-listed alternatives was developed to provide information to the EDO and Chokepoint Planning Workgroup to inform selection of which alternatives are worth pursuing in more detail as part of the final phase of the project.

Alternative screening assumes an existing capacity at HWY 83 below 6ft minor flood stage of 1,700 cfs and a need for an additional 1,300 cfs to meet a target of 3,000 cfs.

1. No-Action Alternative

Concept: The no-action alternative is a continuation of existing actions including vegetation control and CNPPID dredging at the Tri-County Canal Diversion (TCCD). Defining conditions under no-action provides a baseline for which alternatives can be compared.

The current hydraulic capacity at HWY 83 at minor flood stage of 6 feet is 1,760 cfs based on October 2023 survey data and hydraulic modeling. Review of rating curve data at the HWY 83 gage has shown a fluctuation in capacity at minor flood stage between 1,550 up to 2,150 cfs over a period of 20 years, see Figure 1. There is not a consistent trend in either direction. Preliminary findings of the geomorphic assessment being conducted as part of this study indicate that the project reach and hydraulic capacity has been in a general state of quasi-equilibrium with the flow and sediment regimes between 1998 and 2023. The single thread morphology is expected to be the channel form into the foreseeable future based on current hydrology, sediment sources and vegetation management practices that established and maintain a stable channel bed and vegetated banks and floodplain. Thus, average hydraulic capacity is anticipated to continue to be approximately 1,700 cfs with a range between 1,550 and 2,150 cfs depending upon flow conditions.

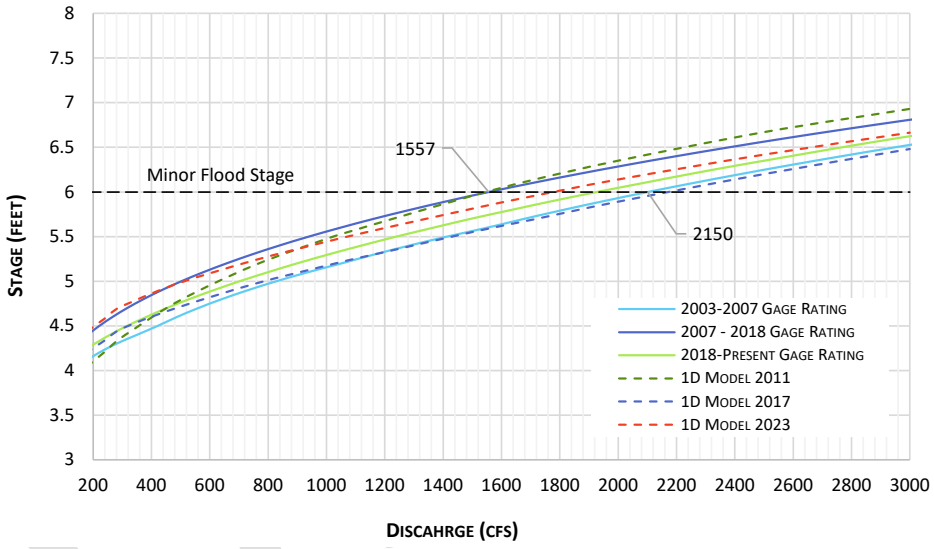

Figure 1. *Stage Discharge Rating Curves at HWY 83 Gage (Gage Data and 1D Hydraulic Model)*

For those reasons, the Program could decide to stay with the status quo, including continued spraying and treatment of invasive vegetation coupled with CNPPID's ongoing dredging at the TCCD and occasional flushing flows as a result of natural events or releases from the Lake McConaughy Environmental Account (EA). This approach would limit cost expenditures and likely maintain delivery of at least 1,500 cfs of EA water downstream of Highway 83 and TCCD.

Summary: No-Action Alternative

Flow Capacity at Confluence vs Flow Target (3,000 cfs): 1,700 cfs (56%)

Percent Increase to Flow Target: none

Est Cost: $0

2. Reduction of Upstream Sediment Sources

Concept: Investigate possibility of reducing upstream sediment sources. The intent of this concept is to minimize incoming sediment load to the Chokepoint in order to maintain and/or improve hydraulic capacity at HWY 83.

The sediment sources to the North Platte River near North Platte, NE are channel, bank, and land erosion from upstream reaches and tributaries, which are also receiving sediment from adjacent hillslopes. Sediment delivery from eroding hillslopes and adjacent upland sources as well as bank erosion is a natural occurring process that is often accelerated by human-induced changes to those natural processes. As discussed in the Geomorphic Assessment memorandum, the construction and operation of Lake McConaughy has cutoff sediment sources from the expansive North Platte River watershed. The watershed downstream of Lake McConaughy is much smaller (1,444 sq mi) and includes Birdwood Creek and several other smaller tributaries (see Figure 2). While some portion of sediment enters directly from adjacent lands, most of the sediment appears to enter the North Platte River as bedload and suspended load from eroding banks and Birdwood Creek and is transported by the river down to the Chokepoint segment and TCCD.

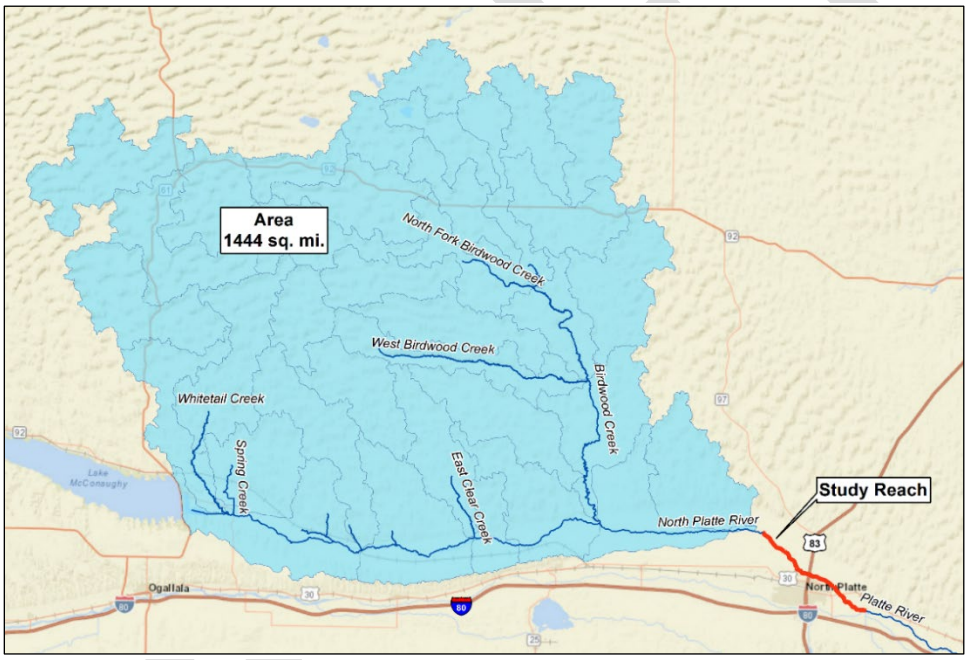

Figure 2. *North Platte River Watershed Downstream of Lake McConaughy*

During the 2023 field visit, we observed Birdwood Creek running sediment laden with no apparent explanation. On the North Platte we also noted acute active bank erosion upstream and downstream of road crossings, but the bank erosion did not appear to be systemic or chronic loading due to lateral migration. In-channel sediment storage in bars and other morphological features was apparent and those features appeared to be migrating downstream, albeit slowly due to bed armoring and dune formation. Further, the quasi-equilibrium state upstream and downstream of Highway 83 suggests that upstream sediment sources are in balance with the river's transport capacity. The EDO and Chokepoint Workgroup could consider performing a detailed sediment source study that would involve evaluating bed materials, geometry, and bed slopes from North Platte, NE up to Lake McConaughy as well as hillslope and tributary

inputs from the North Platte River watershed. Tools such as Watershed Assessment of River Stability and Sediment Supply (WARSSS) or other watershed scale sediment source investigation could be included in that study to quantify the sediment source locations and volumes. That information would inform watershed-wide planning and identify best management practices to control sediment sources. However, because the river has shifted towards a stable form with limited reach-scale bed aggradation, and is generally inactive laterally, limiting bank derived sediment into the system, managing sediment sources across the watershed would likely not significantly change the rating curve or increase the flow passing through the Chokepoint at the minor flood stage.

Summary: Reduce Upstream Sediment Sources
Flow Capacity at Confluence vs Flow Target (3,000 cfs): Unknown
Percent Increase to Flow Target: n/a
Est Cost: Unknown

3. South Platte Reservoir Storage

Concept: Develop reservoir storage to stage EA flows on the South Platte. At this stage the purpose of this alternative is to estimate a storage volume required from the South Platte River to bypass the Chokepoint and meet flow targets on the Central Platte.

Use of reservoir storage within the NPPD and CNPPID systems to stage EA flows has been previously investigated. Storage in the NPPD's Sutherland Reservoir was deemed infeasible given the need for a costly outlet to the South Platte River and lengthy development time. Storage in CNPPID's system was determined to be limited and thus an infeasible solution.

The South Platte Reservoir Storage alternative concept evaluated for the current study would be a new reservoir constructed along the South Platte River between the Colorado-Nebraska state line and the city of North Platte. The volume of reservoir storage required to stage EA flows on the South Platte to meet flow targets on the Central Platte was estimated to inform discussion. Volume estimates were developed for a range of flow rates and durations to supplement existing capacity through the North Platte Chokepoint up to a total flow of 3,000 cfs at the confluence of the North Platte and South Platte rivers. Specific locations for a staging reservoir and diversion logistics were not included in the current scope of work.

Volume estimates assume a release of up to 1,500 cfs would be required from the staging reservoir to supplement 1,500 cfs that can be passed through the North Platte Chokepoint below minor flood stage. This would allow for a 1,500 cfs release for germination suppression even if the entirety of existing capacity at the North Platte Chokepoint is being utilized to meet downstream irrigation demands. Volume estimates assume an average annual evaporation rate of 43 inches/year (per NOAA Technical Report NWS 34) and average annual precipitation of 20 inches/year (High Plains Regional Climate Center, Average Annual Precip 1990-2020) for a net total evaporative loss of 23 inches/year. Volumetric losses associated with transport to the Program's habitat reach on the Central Platte were also included and based on data computed by NDNR during the Spring 2013 short duration medium flow (SDMF) release. The percentage loss of water between Kingsley Dam and Grand Island has been estimated to be as much as 50% during flow releases between 2007 and 2013 (EDO 2014) but ranged from 23% to 29% during the 2013 SDMF

release. Assuming a net evaporative loss of 23 inches/year and a conservative transport loss of 50% the required storage volume was estimated for a range of flows (250 cfs to 1,500 cfs) and durations (10 to 30 days), see Table 1. The storage required to provide 1,500 cfs for a duration of 30 days is approximately 135,600 acre-feet, which would be the upper bound of storage requirement.

Table 1. *Estimated South Platte Reservoir Volumes*

Q (cfs)	Reservoir Volume (acre-feet)	
Duration	10 Days	30 days
250	7,500	22,600
500	15,100	45,200
1,000	30,200	90,400
1,500	45,200	135,600

Summary: South Platte Reservoir Storage

Range of Storage Volume Required: 45,200 – 135,600 acre-feet

Flow Capacity at Confluence vs Flow Target (3,000 cfs): 3,000 cfs (100 %)
Percent Increase to Flow Target: +44% (56% - 100%)
Est Cost: TBD

4. Purchase of Existing Irrigation Infrastructure for Bypass

Concept: Acquire existing irrigation infrastructure that can be used to divert EA flows from the North Platte to the South Platte, bypassing the Chokepoint. The purpose of this alternative is to utilize existing infrastructure to route a portion of EA flows around the Chokepoint. This concept includes conversion of existing surface water users of the canal to groundwater, allowing for the full capacity of the canal to be dedicated to EA water routing.

Upstream irrigation infrastructure capable of diverting flows from the North Platte to South Platte as a means of bypassing the Chokepoint has been previously explored by the Program. A test of EA flow routing through the Keith Lincoln, North Platte, and Suburban canals was conducted as part of the Spring 2013 SDMF release (EDO 2014). Data collected during the 2013 routing was used to determine potential routing capacity and canal losses. Over a 6-day period between April 4 and 10th a peak flow of 30 cfs, 61 cfs, and 28 cfs was diverted from the Keith Lincoln, Suburban, and North Platte canals, respectively. Based on volumes, an overall loss of 45% was measured between diversion points and spills back to the South Platte River. The Keith Lincoln canal had the largest losses of the three canals, likely due to its length. The North Platte had the least amount of loss, but also the smallest amount of diversion. In addition to losses, routing EA water such as that released in June for germination suppression through canal systems would be difficult due to available capacity during the irrigation season.

Additional investigation was conducted to determine the feasibility of purchasing existing irrigation canals that could then be dedicated to bypass. Purchase of the canal infrastructure would require conversion of

existing surface water irrigation to groundwater. Available data was evaluated to identify which irrigation districts/canals might be candidates. The North Platte (Platte Valley Irrigation District) and Suburban (Suburban Irrigation District) canals were identified to have the highest potential based on previous study data, diversion routes, capacity, and loss rates. **These specific districts are identified only for purposes of a preliminary conceptual analysis; representatives of the districts have NOT been contacted to discuss actual feasibility of the alternative.** A map showing both irrigation district boundaries is provided in Figure 3. Active water rights for each canal are summarized in Table 2.

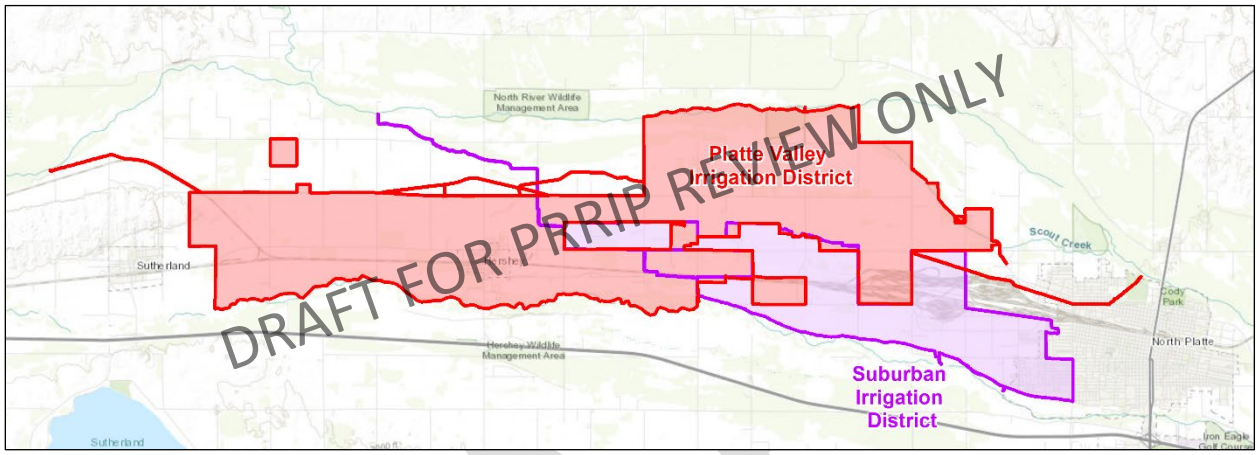

Figure 3. *North Platte and Suburban Canals and Irrigation Districts*

Table 2 Water Rights Summary

Use	Suburban Canal	North Platte Canal
Irrigation from Natural Streams	98 cfs	199.37 cfs
Incidental Underground Storage	15.8 cfs	8.99 cfs
Recharge	77.5 cfs (A-19905)	201 cfs (A-19904)

Source: State of Nebraska DNR – SurfaceWaterRightsSearchIndex

Figure 4 shows the alignment of the North Platte and Suburban Canals. The map also indicates the spill locations of flow diverted back to the South Platte during the 2013 flow test. The figure indicates that the North Platte Canal has its tailwater return to the North Platte River via the Lincoln County Drain No. 1 located just upstream of HWY 83. Use of the North Platte Canal for bypass requires spilling flow into the O'Fallons Lateral and then into the South Platte. This route was used during the 2013 flow test.

Diversion records dating back to 1940 were reviewed to determine the maximum flow discharge for each canal. The Suburban Canal has diverted a maximum of 170 cfs (in 1960) and the North Platte Canal 360 cfs (in 1989). The maximum diversions could potentially account for roughly 5% and 10% of the 3,000 cfs target conveyance through the North Platte Chokepoint. What is unknown at this time is the capacity of the O'Fallons Lateral, which may limit the amount of flow bypass on the North Platte Canal. Records of canal returns to the South Platte River during the 2013 flow test show maximum returns of 22.5 cfs at North Platte Spill No. 1 and 9.0 cfs at North Platte Spill No. 2; thus the capacity of the lateral may only be on the order of 30-35 cfs. To take advantage of the potential capacity of 360 cfs in the North Platte Canal improvements to the O'Fallons Lateral or construction of a new outlet to the South Platte would likely be

required. This would include upsizing of the O'Fallons Lateral crossing under Highway 30 and the Railroad, which would be costly and roughly estimated to be between $1 and $2 million (see bypass canal alternative costs). It is also difficult to extrapolate losses from the 2013 data given the large difference in flows (2013 flow test flows were much smaller than the full capacities and bypass diversions were made into dry canals prior to the start of the irrigation season). However, losses will increase with increasing travel length. The Suburban canal is 13.8 miles in length. The diversion path along the North Platte includes 4.9 miles from the diversion to the O'Fallons Lateral, 2.7 miles to the first existing spill location on the South Platte, and another 5.7 miles to the second spill location on the South Platte. The total travel distance along the North Platte Canal route is 7.6 to 13.3 miles.

Processes and logistics for purchase of canal infrastructure are not clear at this time. The cost for just purchase of infrastructure would be difficult to estimate without a valuation study, which would need to involve the Irrigation Districts. If purchased, canal operations and long-term O&M costs would also need to be considered, as well as how staff and operations of the District would move forward. Both canals currently provide recharge for the Twin Platte Natural Resources District, as indicated by water rights listed in Table 2. Groundwater recharge operations would need to continue and likely be increased to offset conversion of surface users to groundwater. Instead of purchasing the infrastructure, another scenario would be for the Program to compensate districts for conversion of surface water users to groundwater and the districts would continue operation and maintenance of the canal for groundwater recharge.

The irrigated acreage for each canal was reviewed to estimate how many users are currently on center pivot irrigation systems and groundwater wells. A GIS analysis using water rights data from Nebraska Department of Natural Resources (NDNR) and inspection of aerial photography was conducted to provide a rough estimate of the acres that are not currently using a center pivot or sprinkler irrigation. Similarly, the irrigated acreage that currently operates a pivot system but does not draw from groundwater was also estimated based on GIS mapping from NDNR of groundwater well locations. These estimates were developed to quantify how much of the district would need to be converted from surface to groundwater use. Table 3 provides a summary of results, and Figure 5 and Figure 6 show the corresponding mapping. Of the acreage irrigated by the Suburban Canal roughly 2,353 acres (53%) would need to be converted. Roughly 5,754 acres (41%) irrigated by the North Platte Canal would need conversion. Note that these numbers are very rough estimates subject to future refinement.

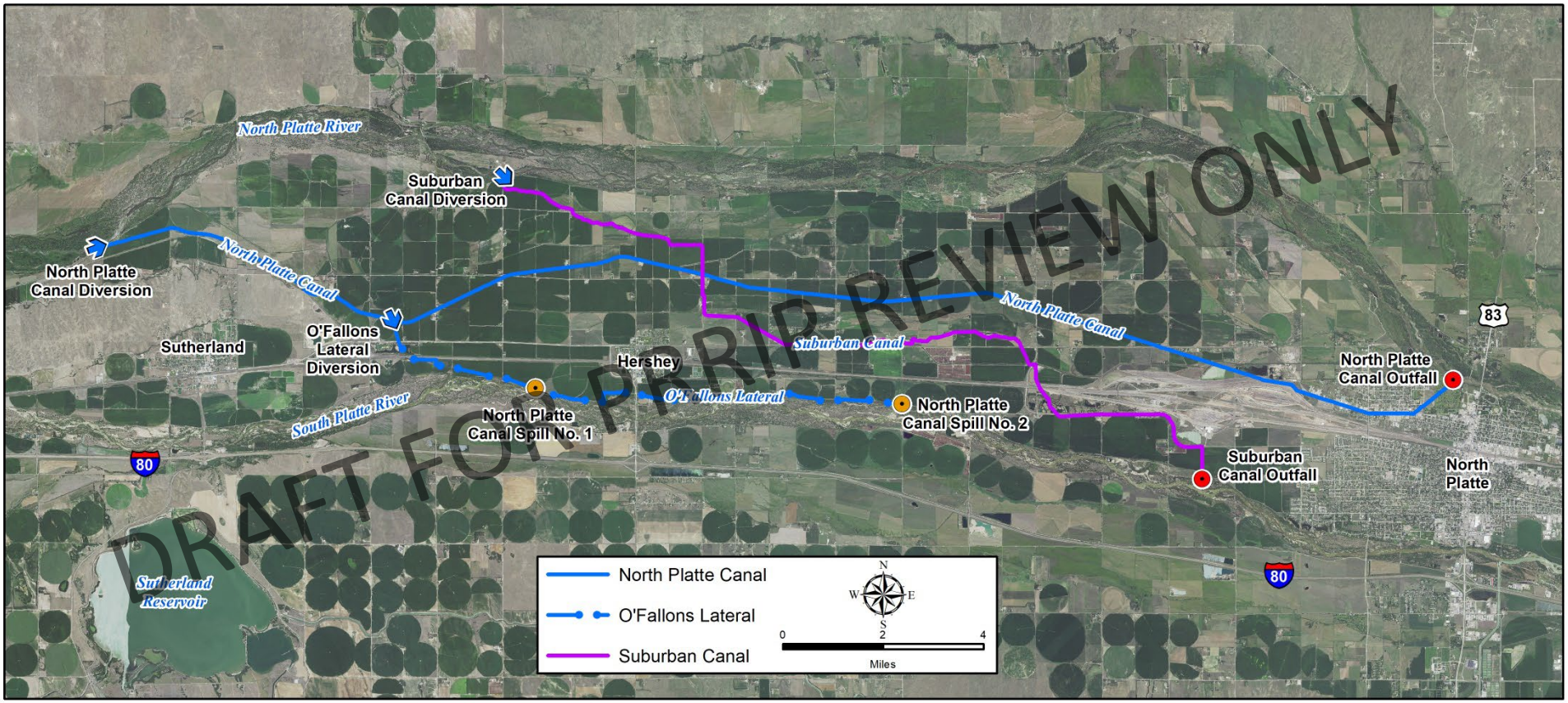

Figure 4. *Alignment and Spill Locations of the Suburban and North Platte Canals*

Table 3 Irrigated Acreage with and without Center Pivots

	Suburban Canal	North Platte Canal
Total Irrigated Acres	4,463 ac	14,105 ac
Irrigated Acres without Pivot Systems	2,353 ac (53%)	5,754 (41%)
Irrigated Acres w/ Pivot Systems	2,110 ac (47%)	8,351 (59%)
Irrigated Acres w/ Pivot Systems not using Groundwater Well	976 ac	726 ac

GIS Data Source: SurfaceWaterRightsBoundaries40AcresExternal DNR | SurfaceWaterRightsBoundaries40AcresExternal DNR | NebraskaMAP

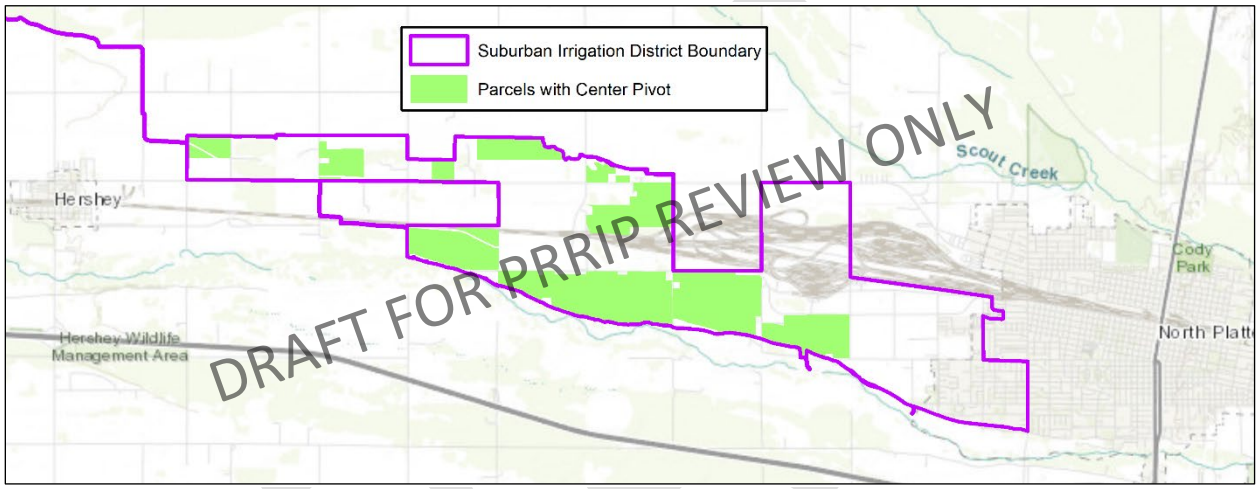

Figure 5. *Map of Suburban Canal Parcels with Center Pivots*

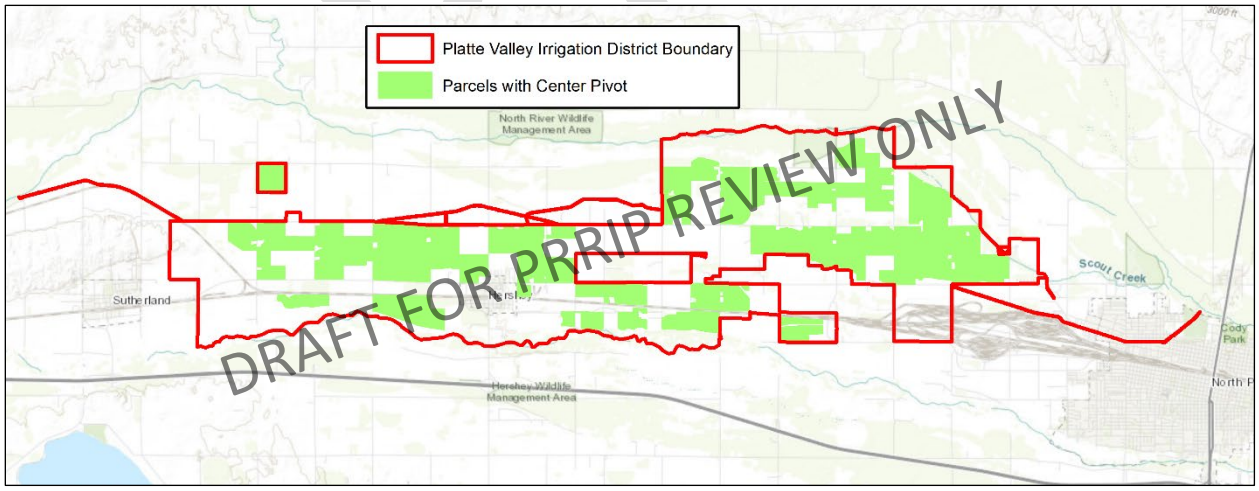

Figure 6. *Map of North Platte Canal Parcels with Center Pivots*

The average cost of a new quarter section center pivot (irrigating about 130 acres of a 160 acre parcel), set up in a field with a concrete pad, is about $90,000. The cost of the pump, well, pipeline, controls and power is estimated at $80,000 per well. The estimated costs to convert surface water users to groundwater for each irrigation district is shown in Table 4. Note that there is some uncertainty in the estimates of acres presented in Table 4 that could be refined with additional investigation.

Table 4 *Estimated Cost to Convert Surface Water Users to Groundwater*

	Acres	# of Irrigated Parcels to Convert [3]	Unit Cost	Cost	Total Cost
Suburban Canal					
Conversion of Surface Irrigation to Pivot/Groundwater Well	2,353	15	$170,000 [1,2]	$2,550,000	
Conversion of Surface Irrigation w Existing Pivot to Groundwater Well	976	6	$80,000 [2]	$480,000	
				Total Cost for Conversion	**$3,030,000**
North Platte Canal					
Conversion of Surface Irrigation to Pivot/Groundwater Well	5,754	36	$170,000 [1,2]	$6,120,000	
Conversion of Surface Irrigation w Existing Pivot to Groundwater Well	726	5	$80,000 [2]	$400,000	
				Total Cost for Conversion	**$6,520,000**

[1] Assumes $90,000 for installation of new center pivot with concrete pad.
[2] Assumes $80,000 for new installation, high capacity, agricultural well. 100 to 300 feet deep, pump included. Approx 6 gpm per acre capacity, ¼ mile center pivot. New electrical supply, overhead, 1,250 feet. Permitting included.
[3] Assumes 160 acre parcels.

The Suburban Canal has the least amount of acreage for conversion, but a smaller capacity for flow and longer travel length when compared with the North Platte Canal. Improvements to the North Platte Canal system would be required to make use of potential capacity. Both canals would require long-term O&M.

Summary: Purchase of Existing Irrigation Infrastructure for Bypass

Suburban Irrigation District and Platte Valley Irrigation District identified as preliminary candidates for evaluation of concept.

<u>Suburban Irrigation District/Suburban Canal</u>

Potential Canal Capacity: 170 cfs

Flow Capacity at Confluence vs Flow Target (3,000 cfs): 1,870 cfs (62%)
Percent Increase to Flow Target: +6% (from 56% - 62%)
Est Cost for Purchase of Infrastructure: TBD
Est Cost to Convert Surface Water Irrigators to Groundwater: $3.0 M
Long Tern O&M Costs: TBD
Permitting: Groundwater Well Permits

<u>Platte Valley Irrigation District/North Platte Canal</u>

Potential Canal Capacity: 360 cfs

Flow Capacity at Confluence vs Flow Target (3,000 cfs): 2,060 cfs (69%)
Percent Increase to Flow Target: +13% (from 56% - 69%)
Est Cost for Purchase of Infrastructure: TBD
Est Cost to Convert Surface Water Irrigators to Groundwater: $6.5 M
Est Capital Cost for Canal Improvements: $1-2 M
Long Tern O&M Costs: TBD
Permitting: Groundwater Well Permits, UPRR Permit

5. Construction of Bypass Canal

Concept: Construct a bypass canal dedicated to routing EA flows around the Chokepoint. The canal would divert flow from the North Platte to the South Platte, bypassing the Chokepoint.

The bypass canal concept and cost developed in 2016 was reviewed and refined. The 2016 concept included construction of a bypass canal aligned parallel to a portion of the North Platte Canal. The bypass canal was sized to convey a maximum flow of 1,500 cfs which requires a bottom width of 60 feet at a slope of 0.0005 ft/ft and total depth of 6 feet, see Figure 7. The 2016 alignment was refined at its downstream end to avoid crossing the railroad tracks twice. Figure 9 shows the refined alignment, location of major crossings that would need to be constructed, and parcel boundaries. There are a total of 23 parcels that intersect the bypass canal alignment. Figure 8 illustrates a typical plan view and cross section associated with the roadway and railroad crossings. Costs were re-evaluated and brought up to date, as shown in Table 5. The estimated capital cost for a 1,500 cfs bypass canal is $13.6 million, with a large portion of that cost related to road, railroad and siphon crossings. Long-term O&M costs are not included.

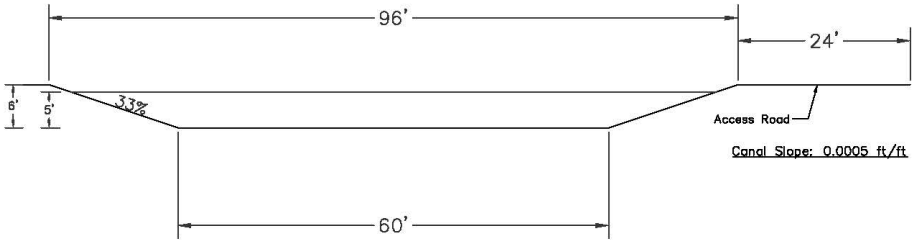

Figure 7. *Bypass Canal Section – 1,500 cfs Capacity*

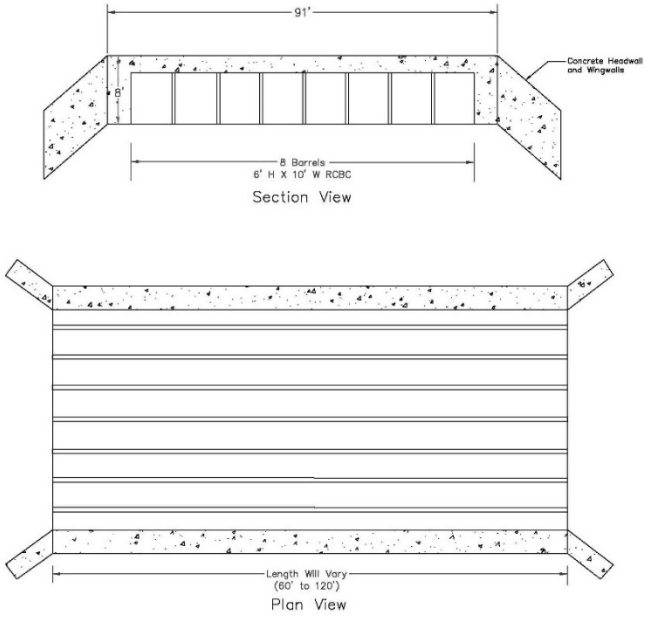

Figure 8. *Typical Canal Road Crossing Structure – 1,500 cfs Canal*

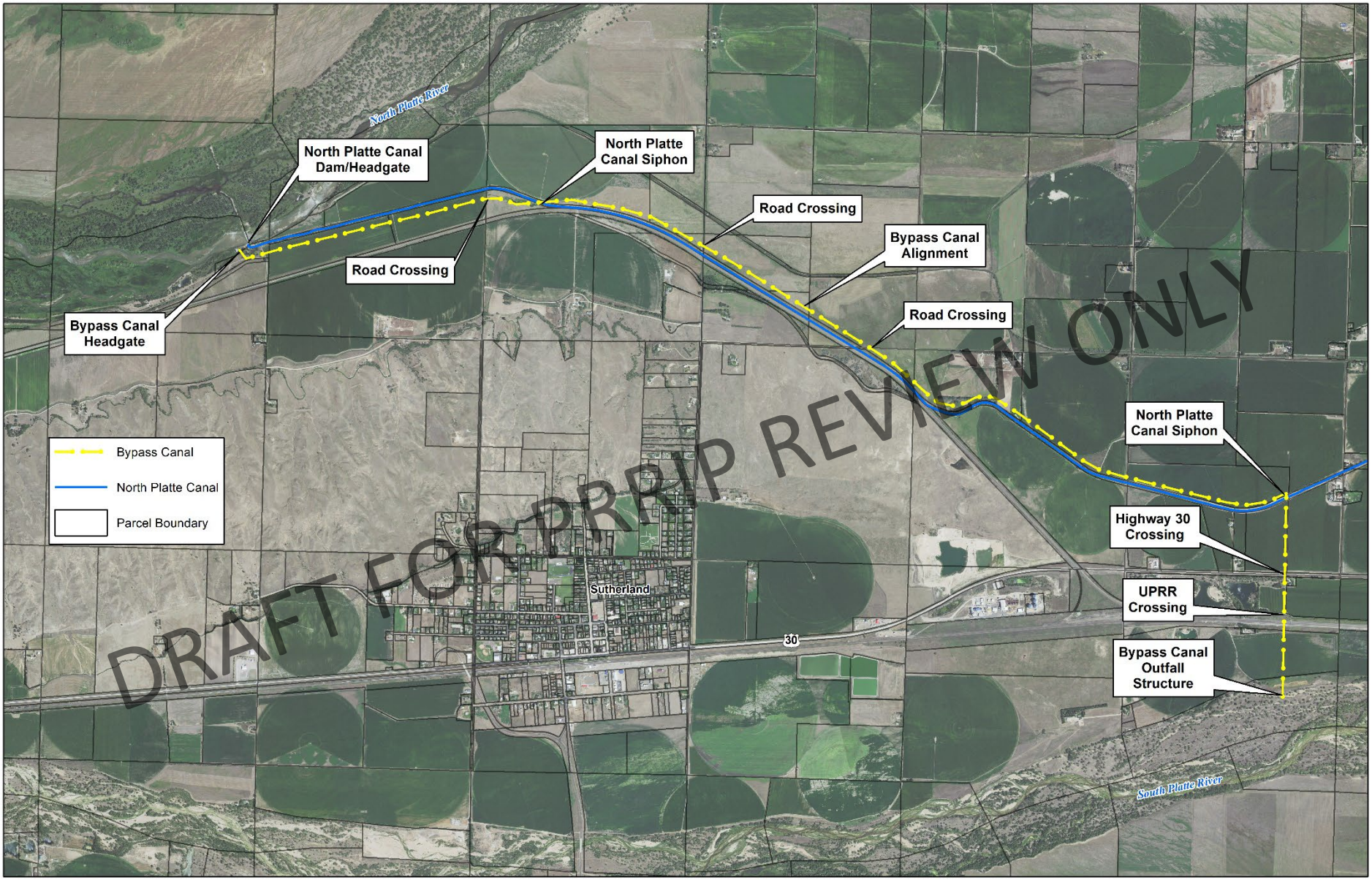

Figure 9. *Alignment of Bypass Canal and Location of Crossings*

Table 5. *1,500 cfs Bypass Canal Cost Estimate*

Item Number	Description	Unit	Estimated Quantity	Unit Cost ($)	Item Cost ($)
1	Diversion Headgate Structure (see Note 1)	LS	1	$1,400,000	$1,400,000
2	Excavation (see Note 2)	CY	573,800	$4.00	$2,295,200
3	Road Crossing #1 (see Note 3)	LS	1	$600,000	$600,000
4	Road Crossing #2 (see Note 4)	LS	1	$983,000	$983,000
5	Road Crossing #3 (see Note 5)	LS	1	$983,000	$983,000
6	Road Crossing #4 (see Note 6)	LS	1	$600,000	$600,000
7	PVID Siphon Crossing #1 (see Note 7)	LS	1	$207,000	$207,000
8	PVID Siphon Crossing #2 (see Note 8)	LS	1	$177,000	$177,000
9	Highway 30 Crossing (see Note 9)	LS	1	$983,000	$983,000
10	UPRR Crossing #1 (see Note 10)	LS	1	$1,600,000	$1,600,000
11	Diversion Outfall Structure	LS	1	$350,000	$350,000
	Land Acquisition				
12	Irrigation (sprinkler)	AC	16	$9,000	$144,000
13	Irrigation (flood)	AC	22	$6,000	$132,000
14	Dry land	AC	34	$2,000	$68,000
	Subtotal				$10,522,200
15	Mobilization/Demobilization	LS	1		$526,110
	Cost of Project Components				$11,048,310
	Engineering Costs	LS	1		$550,000
	Subtotal				$11,598,310
	Contingency (15%)	LS	1		$1,739,747
	Total Project Construction Costs				$13,338,057
	Permitting-Section 404/401 Certification/UPRR (See Note 11)	LS	1	$300,000.00	$300,000
	Easements/Management Agreements	LS	1	$0.00	$0
	TOTAL PROJECT COSTS				**$13,638,057**

Note 1 8-6'Hx8'W gates, concrete headwall, wingwalls, apron
Note 2 Canal, 60' BW/96'TW, 6' high, 3:1 SS
Note 3 50 ft xsing, 400 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 4 90 ft xsing, 720 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 5 90 ft xsing, 720 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 6 50 ft xsing, 400 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 7 120 ft xsing, 6'Hx10"W RCBC, concrete inlet/outlet
Note 8 100 ft xsing, 6'Hx10"W RCBC, concrete inlet/outlet
Note 9 90 ft xsing, 720 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 10 150 ft xsing, 1,200 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 11 Assumes Nationwide Permit, UPRR permit, and 401 permit

A smaller bypass canal with a maximum capacity of 500 cfs was also evaluated to provide a less expensive alternative. The canal cross section for a 500 cfs canal requires a 13-foot bottom width at a channel slope of 0.0005 ft/ft and total depth of 6 feet, see Figure 10. The typical road crossing structures would be reduced in size (see Figure 11). The estimated capital cost for a 500 cfs bypass canal is $7.4 million, as shown in Table 6. Long-term O&M costs were not estimated but would be similar to what would be required for a larger canal.

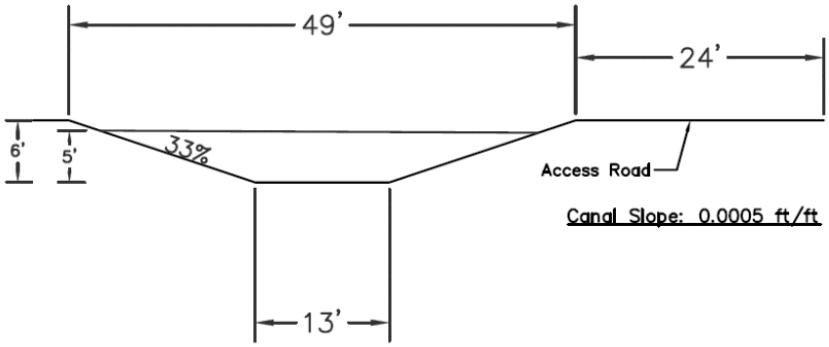

Figure 10. *Bypass Canal Cross Section – 500 cfs Capacity*

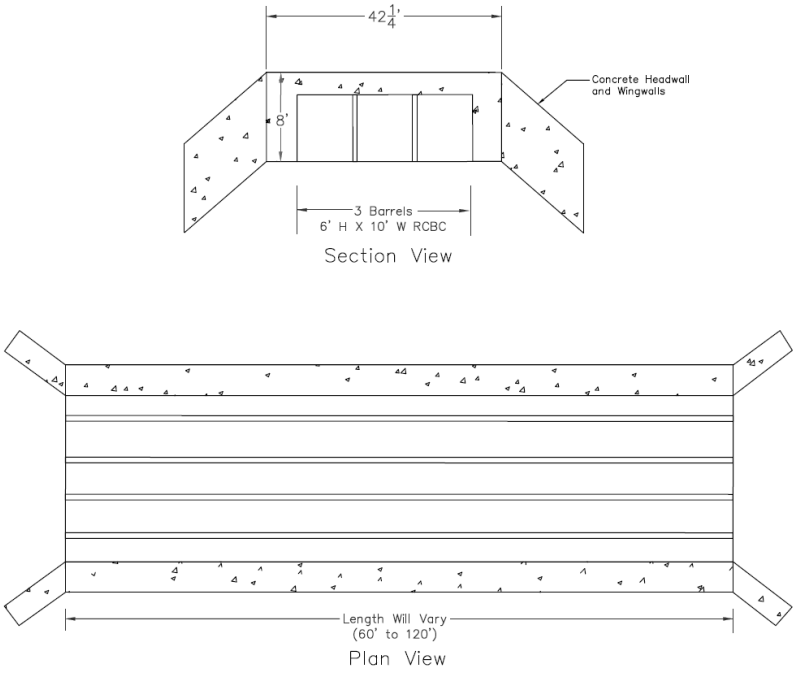

Figure 11. *Typical Canal Road Crossing Structure – 500 cfs Canal*

Table 6. *500 cfs Bypass Canal Cost Estimate*

Item Number	Description	Unit	Estimated Quantity	Unit Cost ($)	Item Cost ($)
1	Diversion Headgate Structure (see Note 1)	LS	1	$520,000	$520,000
2	Excavation (see Note 2)	CY	228,100	$5.00	$1,140,500
3	Road Crossing #1 (see Note 3)	LS	1	$249,000	$249,000
4	Road Crossing #2 (see Note 4)	LS	1	$393,000	$393,000
5	Road Crossing #3 (see Note 5)	LS	1	$393,000	$393,000
6	Road Crossing #4 (see Note 6)	LS	1	$249,000	$249,000
7	PVID Siphon Crossing #1 (see Note 7)	LS	1	$249,000	$249,000
8	PVID Siphon Crossing #2 (see Note 8)	LS	1	$219,000	$219,000
9	Highway 30 Crossing (see Note 9)	LS	1	$393,000	$393,000
10	UPRR Crossing #1 (see Note 10)	LS	1	$609,000	$609,000
11	Diversion Outfall Structure	LS	1	$350,000	$350,000
	Land Acquisition				
12	Irrigation (sprinkler)	AC	16	$9,000	$144,000
13	Irrigation (flood)	AC	22	$6,000	$132,000
14	Dry land	AC	34	$2,000	$68,000
	Subtotal				$5,108,500
7	Mobilization/Demobilization	LS	1		$510,850
	Cost of Project Components				$5,619,350
	Engineering Costs	LS	1		$560,000
	Subtotal				$6,179,350
	Contingency (15%)	LS	1		$926,903
	Total Project Construction Costs				$7,106,253
	Permitting-Section 404/401 Certification/UPRR (See Note 11)	LS	1	$300,000.00	$300,000
	Easements/Management Agreements	LS	1	$0.00	$0
	TOTAL PROJECT COSTS				**$7,406,253**

Note 1 3-6'Hx8'W gates, concrete headwall, wingwalls, apron
Note 2 Canal, 13' BW/49'TW, 6' high, 3:1 SS
Note 3 50 ft xsing, 150 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 4 90 ft xsing, 270 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 5 90 ft xsing, 270 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 6 50 ft xsing, 150 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 7 120 ft xsing, 6'Hx10"W RCBC, concrete inlet/outlet
Note 8 100 ft xsing, 6'Hx10"W RCBC, concrete inlet/outlet
Note 9 90 ft xsing, 270 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 10 150 ft xsing, 450 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 11 Assumes Nationwide Permit, UPRR permit, and 401 permit

Summary: Bypass Canal Alternatives

1,500 cfs Capacity Bypass Canal

Canal Capacity: 1,500 cfs

Flow Capacity at Confluence vs Flow Target (3,000 cfs): 3,000 cfs (100%)
Percent Increase to Flow Target: +44% (from 56% - 100%)
Est Capitol Cost: $13.6 M
Long Tern O&M Costs: TBD
Permitting: Nationwide 404, UPRR Permit, 401 Permit
Number of Private Parcels Impacted: 23

500 cfs Capacity Bypass Canal

Canal Capacity: 500 cfs

Flow Capacity at Confluence vs Flow Target (3,000 cfs): 2,200 cfs (73%)
Percent Increase to Flow Target: +17% (from 56% - 73%)
Est Capitol Cost: $7.4 M
Long Tern O&M Costs: TBD
Permitting: Nationwide 404, UPRR Permit, 401 Permit
Number of Private Parcels Impacted: 23

6. Channel Modification/Sediment Removal

Concept: Construct channel modifications and remove sediment along the North Platte River through the Chokepoint to increase and maintain hydraulic capacity at HWY 83.

Channel modification and sediment removal concepts to increase hydraulic capacity through the North Platte and previously developed by ACE in 2016 and the VESPR Report (River Design Group) in 2023 were reviewed. Both concepts meet or exceed the hydraulic capacity target at HWY 83 through different methods. A brief description of each concept and corresponding capital cost estimate is provided below. Additional discussion regarding development of a combined/refined alternative is also included.

Channel Modification (ACE 2016 Construction Alternative)

An overview of the channel modification ('Construction Alternative') developed in 2016 is shown in Figure 12. This alternative includes construction both upstream and downstream of Highway 83The construction upstream of Highway 83 is intended to achieve a braided channel condition to promote deposition of sediment within the limits of construction to promote sediment continuity. The details associated with the construction upstream of Highway 83 include the following:

- The limits of the channel construction encompass length and width of approximately 16,200 feet and 350 feet, respectively resulting in an area of approximately 130 acres.
- Treatment for vegetation removal of approximately 31 acres (reflects the area of the mid-channel bar)
- Channel widening, material movement and slope grading (130 acres).

Downstream of Highway 83, construction of the improvements is intended to: (a) create a wider channel to promote additional transport during the high flow events, and (b) integrate a constricted low-flow channel that increases the sediment transport during relatively low flows. The specific details of the proposed improvements are listed below:

- Limits of the channel improvements encompass a length of approximately 6,000 feet.
- Creation of a compound channel through channel widening/dredging and placement of jetties/bendway weirs.
- Channel widening to increase the average channel width from 270 feet to a minimum of 300 feet; channel dredging to lower the channel thalweg 1.25 feet to 3 feet.
- Placement of 19 jetties/bendway weirs to constrict the dredged channel to a width of 150 feet. Maximum height of the jetties/bendway weirs not to exceed 2 feet above the channel thalweg. Length varies from 50 feet to 215 feet.

An updated cost estimate is provided in Table 7. This alternative would require work on private land, most likely an individual 404 permit, and floodplain permitting through City of North Platte, Lincoln County and FEMA. The footprint of the project intersects an estimated 62 parcels with 50 individual landowners. It should be noted that no costs have been assumed for access easements or management agreements.

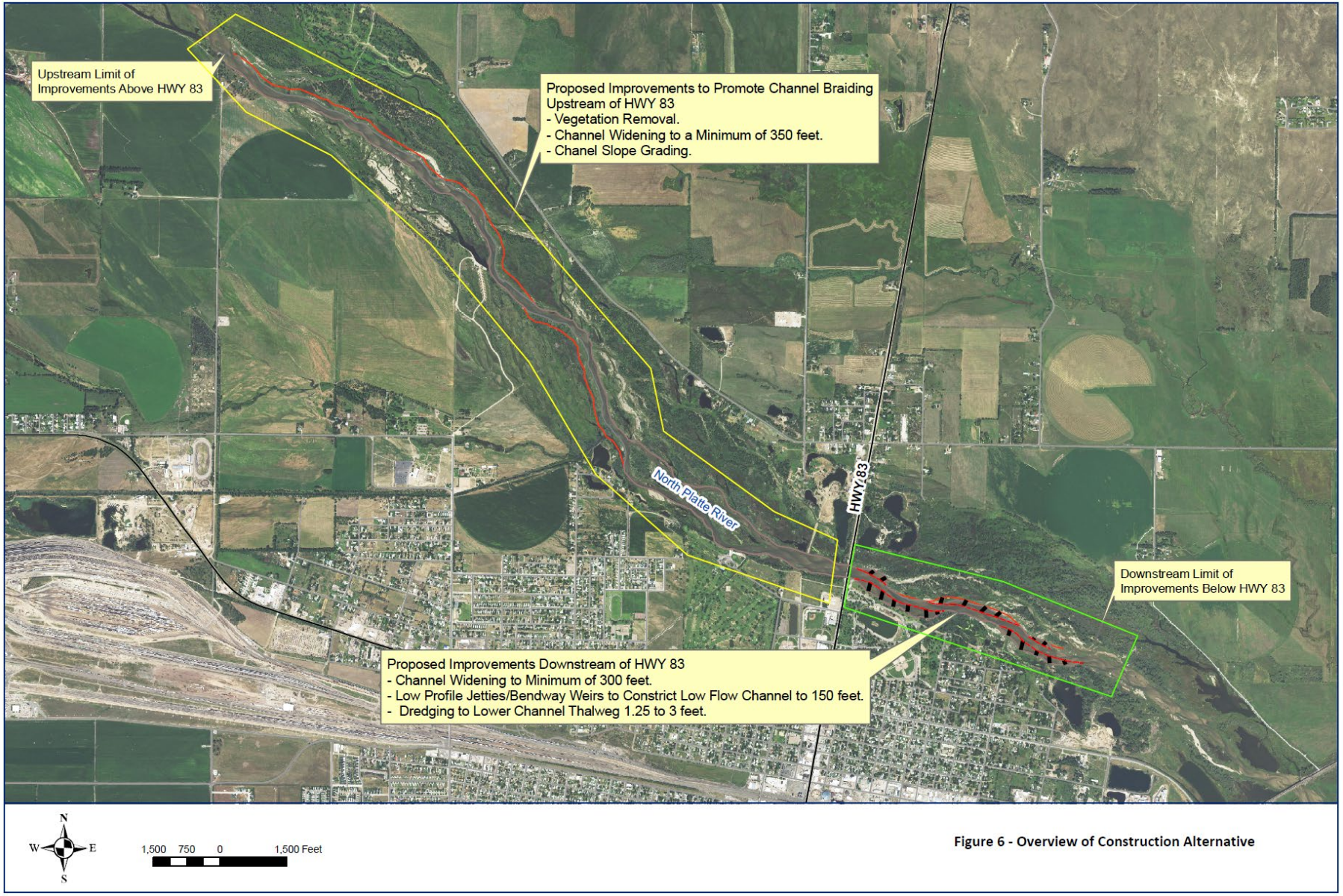

Figure 12. *2016 Construction Alternative (ACE 2016)*

Table 7. *Updated Construction Alternative Cost Estimate*

Item Number	Description	Unit	Estimated Quantity	Unit Cost ($)	Item Cost ($)
Upstream of HWY 83					
1	Vegetation Treatment (see Note 1)	AC	31	$5,500	$170,500
2	Channel Widening (see Note 2)	CY	315,000	$2.00	$630,000
	Subtotal				$800,500
Downstream of HWY 83					
4	Channel Widening/Dredging (See Note 3)	CY	134,000	$8.10	$1,085,400
5	Rock Riprap for 19 jetties/bendway weirs, haul and placement (See Note	CY	8,000	$210	$1,680,000
6	Excavation for Rock Riprap (See Note 5)	CY	11,500	$8.90	$102,350
	Subtotal				$2,867,750
7	Mobilization/Demobilization	LS	1		$366,825
	Cost of Project Components				$4,035,075
	Engineering Costs	LS	1		$200,000
	Subtotal				$4,235,075
	Contingency (15%)	LS	1		$635,261
	Total Project Construction Costs				$4,870,336
	Permitting-Section 404/401 Certification/Floodplain (See Note 6)	LS	1	$300,000	$300,000
	Easements/Management Agreements (See Note 7)	LS	1	$0.00	$0
	TOTAL PROJECT COSTS				**$5,170,336**
Note 1	Removal of vegetation/trees from mid-channel bar (unit cost reflects removal of large trees)				
Note 2	1.5 ft of depth, 130 acres, 350 ft wide; no haul off site required				
Note 3	Average depth of 2 ft, 300 ft wide; $5.10/CY for haul included				
Note 4	Rock quantities include jetty/dike, tie-back into bank, and toe; 2-ft height, 3-ft burial depth				
Note 5	Includes excavation for tie-back, jetty/dike section, toe protection; $5.10/CY for haul included				
Note 6	Assumes Individual Permit/EA, CLOMR/LOMR floodplain permits, and 401 permit				
Note 7	No costs assumed based on previous projects involving "No harm, channel improvements".				

One-dimensional hydraulic and sediment transport modeling of this alternative was conducted by ACE in 2016. Results estimated that hydraulic capacity could be maintained for 3-5 years, but that periodic sediment removal would likely be needed to maintain capacity. As with all sediment transport models there is a level of uncertainty associated with interpretation of results. More current morphodynamic modeling could be conducted to further assess sustainability.

The previous study conducted by ACE in 2016 estimated long term O&M costs of approximately $30,500/year, which assumed vegetation treatment of the large island upstream of HWY 83 every 3 years and removal of approximately 10,000 cy of sediment downstream of HWY 83 every 5 years. Current estimates under the same assumptions put long term O&M estimates at $35,000/year.

Sediment Removal Concept (VESPR 2023)

The 2023 VESPR study provided conceptual level recommendations, one of which included a sediment removal concept (RDG 2023). The concept included excavation of a 200 ft wide channel from upstream of HWY 83 downstream to the Tri-County Canal Diversion (TCCD) to promote an equilibrium slope, see Figure 13. This would increase estimated capacity at HWY 83 to more than 4,600 cfs, exceeding the PRRIP flow target by more than 50%. RDG (2023) estimated that dredging of this magnitude would produce about 1.5 million cubic yards (CY) of sediment requiring disposal, which ACE has refined to about 700,000 CY, see Table 8. Means and locations for disposal of this much sediment have not yet been identified but will be explored in the final phase of this study.

The concept as proposed in the VESPR study also includes modification of the TCCD structure for passage of sediment, which is discussed in the following section. A cost estimate for sediment removal was

developed and is provided in Figure 13. The estimated cost for sediment removal without modification to the TCCD is roughly $7 million, see Table 8. This alternative would require work on private land (roughly 65 private land parcels and 44 individual landowners), most likely an individual 404 permit, and floodplain permitting through City of North Platte, Lincoln County and FEMA.

As noted in the VESPR report, hydraulic and sediment transport modeling of this concept would be needed to determine how sediment removal would impact channel erosion, private properties, sustainability, etc. Additional analyses will be conducted in the next phase of the study to determine what level of sediment removal is optimal.

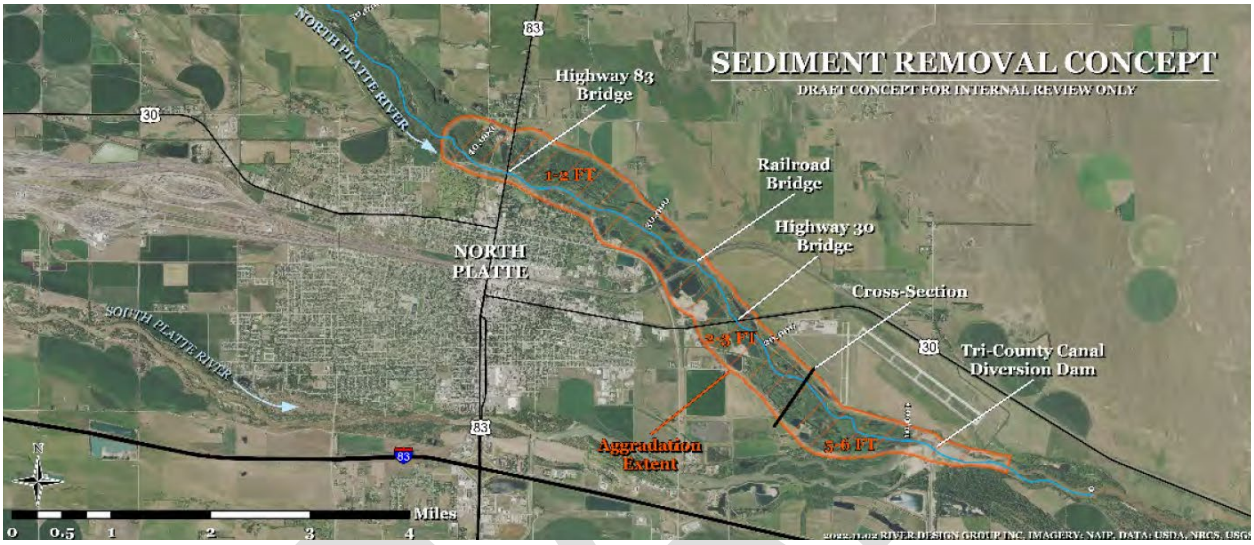

Figure 13. *Sediment Removal Concept – VESPR Report (RDG 2023)*

Table 8. *Sediment Removal Concept Cost Estimate*

Item Number	Description	Unit	Estimated Quantity	Unit Cost ($)	Item Cost ($)
1	Channel Excavation (Note 1)	CY	700,000	$8.10	$5,670,000
	Subtotal				$5,670,000
2	Mobilization/Demobilization	LS	1		$567,000
	Cost of Project Components				$6,237,000
	Engineering Costs	LS	1		$200,000
	Subtotal				$6,437,000
	Contingency (15%)	LS	1		$965,550
	Total Project Construction Costs				$7,402,550
	Permitting-Section 404/401 Certification/Floodplain (See Note 6)	LS	1	$300,000	$300,000
	Easements/Management Agreements (See Note 7)	LS	1	$0.00	$0
	TOTAL PROJECT COSTS				**$7,702,550**
Note 1	200' Wide Channel, 6' x 1.25 miles + 3' x 2.05 miles + 1.5' x 2.9 miles; $5.10/CY for haul included				
Note 2	Assumes Individual Permit/EA, CLOMR/LOMR floodplain permits, and 401 permit				
Note 3	No costs assumed based on previous projects involving "No harm, channel improvements".				

Channel Modification/Sediment Removal Refinement

Both the channel modification and sediment removal concepts discussed above pose a few key questions including:

- How long can increased hydraulic capacity be sustained?
- Would there be costs associated with long-term O&M?
- How can an alternative be developed to work with the river?
- Are there impacts to wetlands (positive or negative) associated with lowering the channel and water table or increasing channel width? Does this pose permitting issues?
- What are options for sediment disposal?
- What are the impacts to private properties?
- Are there other local enhancement opportunities or benefits (flood reduction, habitat, recreation, etc.)?

A refined alternative that would combine elements of both the channel modification and sediment removal concepts above will be developed in the next phase of the study by utilizing results of the geomorphic assessment and updated morphodynamic model (SRH-2D Sediment Modeling). A refined channel alternative can be formulated with the objective of meeting the target hydraulic capacity of 3,000 cfs while minimizing channel work/ sediment removal, maximizing sustainability, and minimizing long term O&M costs. This will require hydraulic and sediment transport/morphodynamic modeling of proposed conditions to inform development of an alternative. Additionally, more detailed information related to permitting requirements and implementation timelines will also be developed.

Summary: Channel Modification/Sediment Removal

Flow Capacity at Confluence vs Flow Target (3,000 cfs): 3,000 cfs (100%)
Percent Increase to Flow Target: +44% (from 56% - 100%)

ACE Channel Modification Concept
Est Capitol Cost: $5.2 M
Long Tern O&M Costs: $35,000/year
Permitting: Individual 404 Permit, FEMA CLOMR/LOMR, 401 Permit
Number of Private Property Parcels Impacted: ~62

VESPR Sediment Removal Concept
Est Capitol Cost: $7.7 M
(Est Capitol Cost w/ Modification to TCCD: $29 M)
Long Tern O&M Costs: TBD
Permitting: Individual 404 Permit, FEMA CLOMR/LOMR, 401 Permit
Number of Private Property Parcels Impacted: ~65

Refined Channel/Sediment Removal Alternative
Est Capitol Cost: TBD
Long Tern O&M Costs: TBD
Permitting: Individual 404 Permit, FEMA CLOMR/LOMR, 401 Permit
Number of Private Property Parcels Impacted: TBD

7. Modification of Tri-County Canal Diversion

Concept: Modify the Tri-County Canal Diversion to allow for sediment passage which has potential to enhance performance and sustainability of the channel modification and sediment removal alternative by promoting sediment continuity.

Modification of the Tri-County Canal Diversion (TCCD) for sediment passage was considered as a potential enhancement that might promote long term sustainability to the channel modification/sediment removal alternative previously described. Several studies have suggested that hydraulic capacity at HWY 83 could be improved through promotion of sediment passage through the TCCD (Parsons 2003, HDR 2011, and RDG 2022). However, previous studies have also stated that there is likely to be limited benefit to hydraulic capacity at the HWY 83 bridge associated with modification to the TCCD alone given the 5.5 miles and 25 feet vertical separation between the structures. Benefits would only be realized if this concept was combined with sediment removal and channel modification in the reach upstream between HWY 83 and the TCCD. Modification to the TCCD to pass additional sediment downstream would be beneficial to CNPPID operations, overall sediment continuity, and downstream river condition. However, it is currently unclear how much added benefit modification of the TCCD would provide to upstream channel improvements.

During a site visit in October of 2023 project staff met with CNPPID to tour the facility and discuss operations, permitting and issues associated with dredging. Under the original FERC license and USACE permitting CNPPID was authorized to dredge and has been doing so since 1965. Permitting also allowed for return of sediment back to the river downstream of the diversion when a minimum flow passed the structure. While this practice did not likely restore full sediment continuity downstream it did provide some level of sediment passage downstream. For the past three years changes to permitting requirements do not allow for return of sediment back to the river, creating significant challenges for CNPPID related to sediment disposal. Challenges associated with sediment disposal expressed by CNPPID would also be an issue for a channel modification/sediment removal project.

The estimated cost to modify the TCCD structure to accommodate sediment passage is $21 million, see Table 9. It should also be noted that invasive aquatic species have been detected downstream of the TCCD, which currently acts as a barrier. Simultaneously passing sediment downstream and restraining fish from migrating upstream is a difficult problem. One possible solution is a BioAcoustic Fish Fence (BAFF) system that could be installed across the dam, but at a significant additional cost. The cost estimate provided for structure modification does not include the BAFF system.

Note that the cost to modify the TCDD is roughly 2 to 4 times the cost estimated for the channel modification/sediment removal alternative. Further investigation (i.e. modeling) would be required to determine what added benefit modification of the TCCD would provide.

Table 9. *Modification of Tri-County Canal Diversion for Sediment Passage Cost Estimate*

Item Number	Description	Unit	Estimated Quantity	Unit Cost ($)	Item Cost ($)
1	Demolition and Clearing (see Note 2)	LS	1	$446,000	$446,000
2	Earthwork (see Note 3)	LS	1	$1,935,000	$1,935,000
3	Overshot Gates (See Note 4)	LS	1	$4,895,000	$4,895,000
4	Concrete/Sheet Piling/Sturctures (See Note 5)	LS	1	$4,866,000	$4,866,000
5	Erosion and Channel Protection Measures (See Note 6)	LS	1	$4,757,000	$4,757,000
	Subtotal				$16,899,000
6	Mobilization/Demobilization	LS	1		$844,950
	Cost of Project Components				$17,743,950
	Engineering Costs	LS	1		$530,000
	Subtotal				$18,273,950
	Contingency (15%)	LS	1		$2,741,093
	Total Project Construction Costs				$21,015,043
	Permitting-Section 404/401 Certification/Floodplain (See Note 7)	LS	1	$300,000	$300,000
	TOTAL PROJECT COSTS				**$21,315,043**

Note 1	Line item costs adjusted for inflation (+24%), location (-9%) and quantity from similar project on South Platte River near Evans, CO. in 2017.
Note 2	Complete removal of existing river dam,foundations and debris. Canal headgates remain.
Note 3	Structure excavation, fill, hauling and dewatering.
Note 4	Fully controllable crest using Obermeyer type overshot gates. 870 ft span.
Note 5	Concrete cap and apron over sheet piling. 870 ft span.
Note 6	Erosion and sediment control during construction and channel protection measures.
Note 7	Assumes Individual Permit/EA, CLOMR/LOMR floodplain permits, and 401 permit

Summary: Modification to Tri-County Canal Diversion

This concept would be an add on to a channel modification/sediment removal alternative.

Flow Capacity at Confluence vs Flow Target (3,000 cfs): 1,700 cfs (100%)

Percent Increase to Flow Target: 0%

Est Capitol Cost: $21.3 M

(Est Capitol Cost VESPR Sediment Removal + Modification to TCCD: $29M)

Long Term O&M Costs: TBD

Permitting: Nationwide 404 Permit, FEMA CLOMR/LOMR, 401 Permit

Comparison of Alternatives

At HWY 83 the existing conveyance capacity at minor flood stage is about 1,700 cfs, , which accounts for 56% of the Program's 3,000 cfs capacity target. The goal of the alternatives considered herein is to increase hydraulic capacity through the North Platte Chokepoint to 3,000 cfs or provide a means of flow bypass that in combination with existing North Platte Chokepoint capacity will result in 3,000 cfs at the confluence of the North Platte and South Platte rivers.

The percent of the 3,000 cfs target that can be achieved by each alternative along with the corresponding capital cost is compared visually in Figure 14. Table 10 provides a summary comparison of flow capacity, capital costs, long term O&M, permitting, and number of properties impacted. The South Platte storage, 1,500 cfs bypass canal, channel modification, and sediment removal alternatives meet or exceed the 3,000 cfs flow target. Purchase of irrigation infrastructure and the 500 cfs bypass canal only provide a 10 to 15% increase towards the target but still fall short by roughly 30%. Of the alternatives that can achieve target flows, the channel modification and sediment removal have the lowest capitol cost. Long-term O&M costs are not included in the comparison. A storage reservoir and bypass canal will have long-term maintenance costs. Long-term maintenance of a channel solution has less potential for long-term maintenance. Additional study is required to determine how sustainable a channel solution could be in the long term.

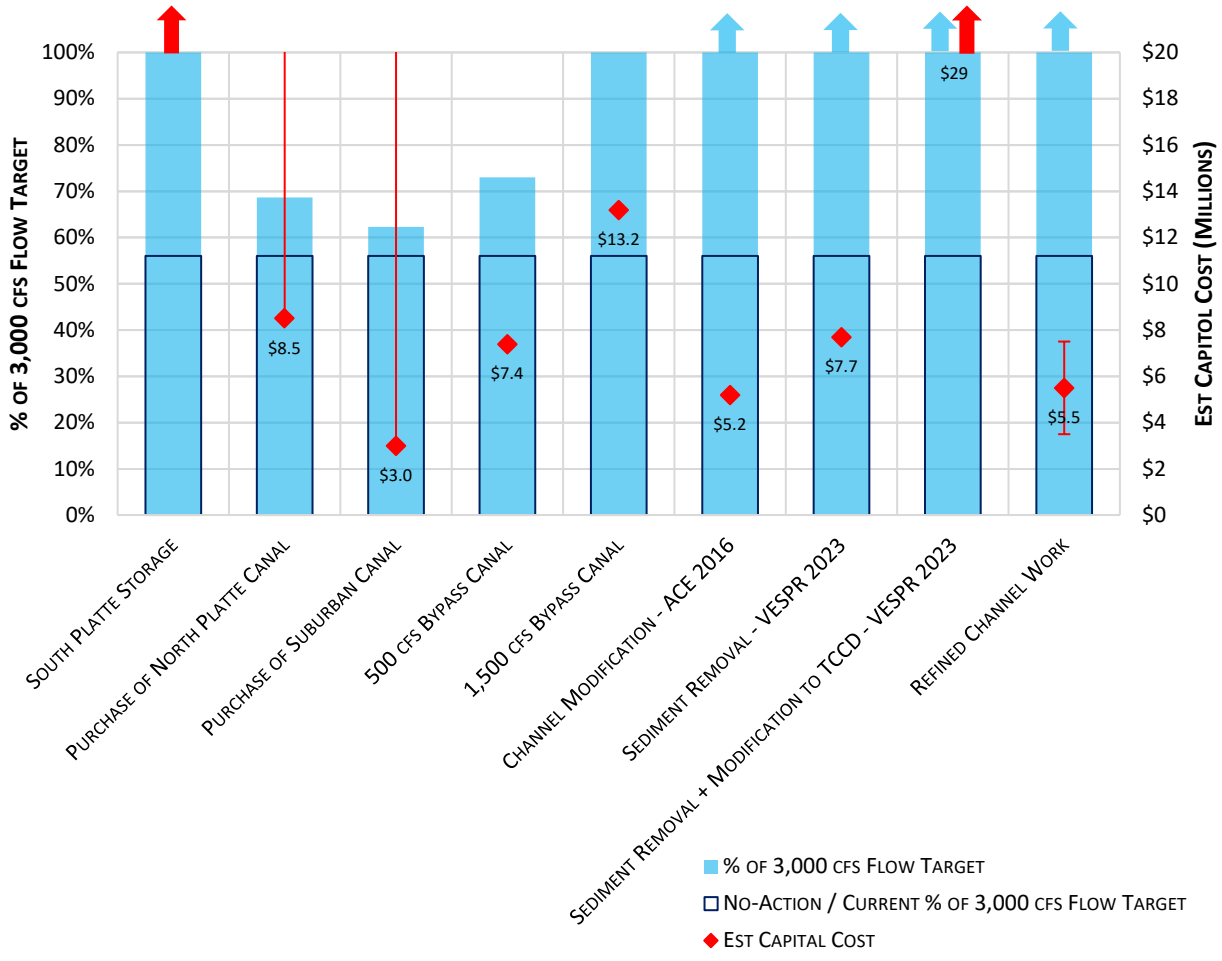

Figure 14. *Comparison of Alternative Benefit to Flow Target and Est Capital Cost*

Table 10. *Alternative Comparison*

Alternative	Flow Capacity at HWY 83 (cfs)	Bypass Flow (cfs)	Total Flow to Central Platte (cfs)	% of 3,000 cfs Flow Target	Estimated Capital Cost	Long Term O&M Required?	Long Term O&M Costs	Permitting	Number of Private Parcels Impacted
No-Action	1,700	--	1,700	56%	$0	No	none	none	n/a
South Platte Storage	1,700	1,500	3,200	100%	>> $20 M [2]	Yes	TBD		TBD
Purchase of Irrigation Infrastructure North Platte Canal	1,700	360 [1]	2,060	69%	Purchase: TBD [3] Conversion: $6.5M Improvements: $1-2M	Yes	TBD	Groundwater UPRR Permit	n/a
Purchase of Irrigation Infrastructure Suburban Canal	1,700	170	1,870	62%	Purchase: TBD [3] Conversion: $3.0 M	Yes	TBD	Groundwater	n/a
500 cfs Bypass Canal	1,700	500	2,200	73%	$7.4 M	Yes	TBD	Nationwide 404/401 UPRR Permit FEMA Floodplain	23
1,500 cfs Bypass Canal	1,700	1,500	3,200	100%	$13.2 M	Yes	TBD	Nationwide 404/401 UPRR Permit FEMA Floodplain	23
Channel Modification (ACE 2016)	3,000 +	--	3,000 +	100% +	$5.2 M	Yes	$35,000/yr	Individual 404/401 FEMA Floodplain	62
Sediment Removal (VESPR 2023)	3,000 +	--	3,000 +	100% +	$7.7 M	TBD	TBD	Individual 404/401 FEMA Floodplain	65
Sediment Removal (VESPR 2023) + Modification to TCCD	3,000 +	--	3,000 +	100% +	$29 M	TBD	TBD	Individual 404/401 FEMA Floodplain	65
Channel Mod/Sed Removal (TBD)	3,000 +	--	3,000 +	100% +	TBD	TBD	TBD	Individual 404/401 FEMA Floodplain	TBD

[1] 360 cfs is the best-case scenario using the North Platte River. Improvements to O'Fallons Lateral would be needed.
[2] Location, cost, and details of developing storage on the South Platte not included in evaluation.
[3] Details and costs related to purchase are difficult to estimate, currently not enough information to provide a full cost estimate.

References:

ACE (2023). Memorandum, North Platte Chokepoint Geomorphic Assessment (January 26).

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